The Nai‘a Guide 2.0:
Utilizing Mobile Apps for Marine Conservation Efforts

By

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May 2015

Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University

Executive Summary

Smartphones and apps have become an integral part of our daily lives. As of December 2014, 75% of Americans own a smartphone. iTunes, servicing Apple products, has 1.2 million apps and Google Play, servicing Android products, has 1.3 million apps. Given the popularity of such devices, smartphones and apps are an effective resource to reach the general public, but underutilized by those in the marine conservation field. As such, I present in this paper a way for organizations to take advantage of these tools for their own initiatives, using the example of the Naiʻa Guide. In addition, I explore the search function capability of the two app stores and perform a series of interviews to gain insight in the app making process.

Before delving into the Naiʻa Guide app, a brief background is needed. Watching or swimming with marine wildlife has become a popular tourism activity. While ecotourism can increase public awareness, numerous studies suggest such tourism negatively impacts the targeted wildlife. Hawaiian spinner dolphins (*Stenella longirostris longirostris*) are one example. These dolphins have a highly regulated 24-hour life cycle, which involves feeding offshore at night, resting close to shore in shallow waters during the early morning hours, and socializing in the afternoon. Because of this predictable near-shore behavior, a tourism industry has been established, often resulting in harassment of the dolphins, especially during their resting period. While spinner dolphins are protected by the Marine Mammal Protection Act and by voluntary regulations by the National Oceanic and Atmospheric Administration, harassment is still a problem. One proposed solution was an iPad app to educate the public about the dolphin's biology and proper interaction etiquette. For a variety of reason, a new app needed to be built, resulting in my contribution to the project.

To replace the current iTunes app, I built a web-based app. Rather than downloading the app from an app store, it is accessed through a website (www.naiaguide.com/naia2) and saved to your device's homescreen. There are many benefits to using a web-based app. First, WordPress is designed to be used by those with no web design background. Second, since web-based apps are websites, it will conform to any screen size on any device, eliminating the need for apps on multiple platforms. Finally, app maintenance is simplified as keeping up with operating system updates by Apple and Android is not necessary. However the downside of web-based apps through WordPress is not being able to add more technical elements to the app, such as uploading photos or adding GPS coordinates.

Given that people are rarely without their phones, this offers an opportunity for people to directly participate in marine conservation. A citizen science section will be added by an external developer to the Naiʻa Guide app for users to upload photos of spinner dolphins and import their GPS location to aid in photographic identification and capture the intense tourism pressures. Data from these uploads can be used in photo ID research, aid with enforcement of the MMPA, and encourage a community policing system. By participating in citizen science, people are more likely to become interested in and connected with the issue.

The second component of this project involved a search of the iTunes and Google Play app stores. Since about half of Apple and Android users search for apps in their

respective stores, an effective search function is important. I first searched iTunes with the keywords ‘ocean’, ‘conservation’, ‘environment’, and ‘science’ and tallied the results. The results are as follows with the total number of apps and percentage of apps in the iTunes store in parentheses: ocean (3,813; 0.318%), conservation (296; 0.025%), environment (1,032; 0.086%), and science (5,874; 0.49%). I then reviewed the top 50 results for each keyword and determined relevance using a list of 15 app types, paying particular attention to the categories of ‘species education’ and ‘citizen science’ as they best relate to an app like the Nai‘a Guide.

The results for ‘ocean’ were primarily made up of non-ocean educational games or sound/visual stimulants. ‘Conservation’ had a broad range of categories, the largest of which was ‘green living’ on ways to conserve energy and water for specific companies. ‘Environment’ also ranged across multiple categories, including ‘news/magazine’, ‘games’, and ‘industry/group’ for iTunes and ‘industry/group’, ‘academic-environmental’, and ‘news/magazine- environmental’ for Google Play. ‘Science’ had a narrow range of results, with the majority of iTunes and Google Play apps consisting of ‘news/magazine’ and ‘academic’, respectively. Very few results for any keyword at either store consisted of ‘species education’ or ‘citizen science’ apps. The results suggest that not only do the current environmental conservation apps make up an insignificant portion of the total apps available, a large number of search results are not relevant to that keyword. An advanced search function in the app stores would be beneficial for users to better find the app they are looking for.

Finally, I conducted interviews with organizations with relevant apps to learn about their app development process and provide recommendations for future app development, resulting in several key points. First, working with partners is important, particularly if the organization doesn’t have the development expertise. Second, half of the respondents funded the app in-house, while the other half received outside funding. Third, all organizations used media to announce the app’s release including mailings and social media. One group noted the importance of having a strong outreach strategy. Lastly, many respondents noted the importance of working with user groups during the app’s creation to ensure the app will fit their needs.

In conclusion, mobile apps, whether web-based or regular, provide a great opportunity for the public to become more involved and educated in marine conservation issues. However they are greatly underutilized and underrepresented in the app stores. Organizations should consider integrating this education tool in their outreach strategies. By taking advantage of today’s rapidly advancing technologies, we have the opportunity to reach a wider audience and make a difference in marine conservation issues.

Contents

Introduction

I. Mobile Phones and Apps

Bill Gates once said "The advance of technology is based on making it fit in so that you don't really even notice it, so it it's a part of everyday life" (Mohan, 2012). Nowadays, that is exactly what mobile devices have become: a technological advancement that is part of the majority of people's everyday lives. According to a recent report by comScore, Inc. released on February 9, 2015, 75% of Americans own a smartphone as of December 2014. For the past several years, Google has released a report called Our Mobile Planet, which breaks down smartphone usage in America. The most recent report is from 2013, when at the time only 56% of Americans owned a smartphone (Google, 2013). Of that 56%, almost 60% perform a search on their phone every day, of which 40% of the people search for travel information (Google, 2013). This is important, as many ecotourism issues involve tourists that have traveled from somewhere. Regardless if someone is a tourist or simply visiting the beach down the road, the fact that 94% of people search for local information and 84% take action a result of that search has important implications (Google, 2013). For example, the tourist may search when they are at a location for dolphin ecotours (a local search at that time) or the local citizen who lives near the beach may search for how to report a stranded marine mammal, either potentially leading to the relevant apps.

For all the bells and whistles that come with smartphones, they just wouldn't be the same without apps. Apps, short for applications, are software programs that can be downloaded on mobile devices. They allow the user to quickly access a program rather than having to search for it on the internet each time they want to use it. Depending on the device, apps can be downloaded in either the iTunes App Store (Apple products) or Google Play (Android products). As of July 2014, there were 1.2 million apps available through iTunes and 1.3 million apps available on Google Play (Statista, 2014). This goes to show the popularity of apps among consumers and developers. Given this popularity of apps and smartphones as well as the ease of access, these tools are now a highly effective way of reaching the public to get a particular message across. As a result, an app called The Nai'a Guide was created to help improve the spinner dolphin ecotourism situation in

Hawaii. However before the development and details of the app are described, an explanation on why an app is needed for this situation is required.

II. Marine Wildlife Ecotourism

In part thanks to pop culture icons such as Flipper and Free Willy, watching or swimming with marine animals has become a much desired activity for tourists to participate in during vacations. In 2008, almost 13 million people globally participated in such whale watching activities (O'Conner, Campbell, Cortez, & Knowles, 2009). This industry has doubled in global expenditures in the past 10 years, from $1 billion in 1998 to $2.1 billion in 2008 (O'Conner et al., 2009). North America alone had nearly half of the 2008 expenditures and number of whale watchers (O'Conner et al., 2009).

One aspect of ecotourism that has become particularly popular is 'swim-with' interactions. Rather than simply observing the animals from a boat, participants enter the water with the animals for a more up close and personal experience. Both boat-based and swim-with tours arguably have their advantages to benefiting marine wildlife. Such interactions provide a more profound connection with the animals that often generates an increased public awareness of environmental issues and action. This can lead to making more environmentally sound choices in their daily lives or increased support for non-profit organizations (Buckley, 2009).

Despite these potential positive outcomes, there is a long list of documented negative impacts to the species from both the tour vessels and swimmers. A study on dusky dolphins in New Zealand found a decrease in resting and an increase in traveling behaviors when tour boats were present (Lundquist, Gemmell, & Wursig, 2012). Killer whales in British Columbia were found to decrease time spent foraging in the presence of tour boats (Williams, Lusseau, & Hammond, 2006). The impact of swim-with programs on manatees in Florida has also been evaluated. One study found that when swimmers are present, manatees decrease lower energy activities such as resting and nursing and increase higher energy activities of milling and swimming (King & Heinen, 2004). A

common theme in these examples is increasing the animal's energetic cost, either through an increase in activity or decrease in energy intake.

The impacts of ecotourism and ways to potentially manage it is a substantial enough topic to be a paper all on its own. However, that is not the focus of this project. Rather this paper will focus on the outreach potential of mobile apps to educate the public on marine conservation issues, how they are currently underutilized and the different options interested developers can use. As an example throughout, I will focus on Hawaiian spinner dolphins.

III. Hawaiian Spinner Dolphins and Ecotourism

Hawaiian spinner dolphins (*Stenella longirostris longirostris*) are a subspecies of the larger spinner dolphin taxa (IUCN, 2012). These dolphins are relatively small compared to other dolphin species and have unique color markings. They have a dark gray "cape" on their dorsal surface, a white belly, and a light gray band in between (Norris & Dohl, 1980). The spinner dolphin beak, also called a rostrum, is long and slim, hence the scientific name "longirostris". A dark band runs from their beak to their pectoral fin on each side.

Spinner dolphins live on a highly regulated 24-hour life cycle. At night they move offshore to feed on their prey (fish, shrimp, and squid) that moves closer to the surface at that time. These prey items are small and do not provide significant energetic intake individually for the dolphins. To increase energetic intake, spinner dolphins use a foraging method called cooperative feeding. Here the dolphins work together as a group to encircle a prey group, then take turns in pairs moving into the prey circle to feed. (Benoit-Bird & Au, 2009). After they have finished feeding, spinner dolphins head back towards shore to rest, usually arriving in the resting bays between 6:00am and 10:00am (Norris & Dohl, 1980). Dolphins then rest for about 2 hours (Norris & Dohl, 1980). The characteristics of the resting bays are key for the dolphins. They prefer shallow water, less than 50 meters, and sandy bottoms, which make it easier to see predators in the area such as sharks (Danil, Maldini, & Marten, 2005).

After the resting period, there is an abrupt transition to being active through aerial behaviors. Once one dolphin starts being active, the rest of the group is awake shortly thereafter. This period of socialization can be expressed through a variety of aerial behaviors, including spins, leaps, tail-over-head leaps, backslaps, headslaps, tailslaps, and noseouts (Norris & Dohl, 1980). As night falls, the spinner dolphins move offshore again to start the cycle over.

Because the spinner dolphins have such a predictable daily cycle of coming close to shore during the day, a tourism industry has developed around these activities. Tourism involving swimming with the dolphins began in Hawaii in the 1980s and has grown ever since (Ostman-Lind, 2009). This activity and the increased human presence has naturally had an impact on the small dolphin population. One study on the spinner dolphins residing off the Kona coast on the Big Island of Hawaii found an increase in high energy activities (aerial behaviors and fast swimming) when humans were present (Ostman-Lind, 2009). This is a similar result to the previously mentioned studies on human impacts to other dolphin species and manatees. For the spinner dolphins, an increase in energetic activities instead of resting can have long-term consequences on their ability to forage at night and protect themselves and their calves from predators (Ostman-Lind, 2009). Additionally, a second study on spinner dolphins off the coast of Oahu similarly found a delay and compression of the dolphin's resting time when humans were present (Danil, et al., 2005).

Spinner dolphins are currently federally protected under the Marine Mammal Protection Act (MMPA). This act makes it illegal to take a marine mammal, where "take" is defined as "to harass, hunt, capture, or kill" or to attempt any of these activities (Marine Mammal Protection Act, 1972). The term "harass" is further defined as "any act of pursuit, torment, or annoyance" which may injure a marine mammal or negatively impact their behavior in terms of breeding, feeding, migrating, breathing, or sheltering (Marine Mammal Protection Act, 1972). However, these definitions have proven difficult to actually enforce in the field, therefore resulting in minimal real protection for the animals. In addition to federal law, the National Oceanic and Atmospheric

Administration (NOAA) has published a series of guidelines regarding interactions with marine wildlife, divided up into the five regions of the U.S with the Pacific Region covering Hawaii. These region-specific guidelines recommend keeping a 50 foot buffer from marine mammals, a 100 foot buffer for humpback whales, and not to swim with wild spinner dolphins. However these are not legally enforceable regulations unless the act violates the MMPA (NOAA Fisheries, 2013). NOAA also states that they do not "support, condone, approve, or authorize activities that involve closely approaching, interacting, or attempting to interact with whales, dolphins, porpoises, seals, or sea lions in the wild", which includes swimming with the animals (NOAA Fisheries, 2013). Yet despite these regulations, harassment still regularly occurs.

The question remains on how to best manage the spinner dolphin ecotourism industry. There have been a number of proposed solutions in the past, including strengthening the definition of harassment in the MMPA, implementing a permitting system for tour operators, setting time or area closures, and increasing enforcement (Fox, 2013). Just recently in March 2015, Concurrent Resolution 48 was proposed in the Hawaii State Senate, which encourages the State of Hawaii to work with its federal partners to strengthen the laws protecting indigenous marine wildlife, including spinner dolphins (DLNR, 2015). But rather than explore the expansive topic of the various management options, I will focus on one potential solution that can be applicable to a variety of marine conservation issues.

Methods and Results

I. The Naiʻa Guide

The Naiʻa Guide app was originally created by former Coastal Environmental Management (CEM) student Demi Fox and was released in the iTunes App Store in May 2013 for the iPad. The app was created through a company called Kleverbeast, which for a monthly fee allowed non-developers to create an app. The primary purpose of this app was to educate people, particularly tourists, about the behavior of spinner dolphins and the proper ways to interact with them. In addition to extensive text, the app contained videos, photos, and sound clips. However, Kleverbeast sent a notification to Demi on

November 22, 2013 stating they would no longer be offering app creation service, leaving elements of the Naiʻa Guide app unstable. For example, clicking on a video clip will not play the video and will instead force the app to close. Combing these issues with the fact that the app was only accessible to people with iPads, it was clear that a new version of the app was necessary.

II. The Naiʻa Guide 2.0

The second version of the Naiʻa Guide app was created very differently compared to the first version. Rather than creating an actual app to be offered in the iTunes store, I instead created a web-based app using WordPress, a website building program for people with limited website design skills, such as myself. To access a web-based app, you simply go to the website (www.naiaguide.com/naia2) on any mobile device and click the "add to homescreen" option that pops up. This will save the webpage to the device's homescreen with any chosen image, in this case the previously designed Naiʻa Guide app image found in the App Store, just like a regular app.

The first step I took to create the Naiʻa Guide 2.0 was to choose a theme for the website. Themes are essentially the style and layout of the webpage. There are hundreds of WordPress themes available to choose from, both on the WordPress site and independent websites that sell themes. I knew my website was being designed to be used on mobile devices, so I limited the theme search to mobile versions. I used a website called Theme Forest to search for an appropriate theme. Searching for mobile WordPress themes resulted in approximately 40 hits. I viewed each one to see which style I liked best and settled on the Mobiles Mobile theme.

After the theme was applied in WordPress, the next step was to set up the menus. The former Naiʻa Guide had five main menu options: Ecology, Spinner Science, Human Impact, In the Wild, and Sustainable Tours. Each of these had their own subset of menu options. I decided to rename and reorganize the main menu into Biology, Studying Spinners, Human Impacts, Responsible Viewing, and Participate. Part of this new app will include a section where people can submit their own photos and recorded

interactions with spinner dolphins, which will be found under the "Participate" menu. This is an effort to encourage citizen science, a topic to be discussed later. As the Mobiles Mobile theme limited me to 5 main menu options, I decided to combine the previous menus of "Into the Wild" and "Sustainable Tours" into "Responsible Viewing".

As I continued working on other aspects of the app, I began noticing some issues with the Mobiles Mobile theme. The biggest issue was the lack of responsiveness, meaning the app did not conform properly to the screen size of whatever device it was being displayed on. As this was one of the primary reasons a web-based app was to be used, clearly the Mobiles Mobile theme was not the best option. I then began a new search for themes, but this time searching for responsive themes rather than mobile themes. The theme I chose was the WordPress 2014 theme. This free theme (another difference from the Mobiles Mobile theme which cost about $40) is a standard WordPress theme that offered greater responsiveness and simplicity, which was beneficial for a non-programmer.

Once the theme was switched, it became much simpler to adjust components the way I wanted. For example, the color scheme that came with the theme (lime green and black) were not appropriate to my project. Therefore, I searched and found a Plugin that allowed me to change the colors to blue and black. Plugins are extended applications that can be added to almost any theme that allow for additional features. In this case, a plugin called Fourteen Colors allowed me to change the colors of the WordPress 2014 theme that otherwise would have required coding knowledge I don't have.

I also made some adjustments to the menu with the new theme. As I was no longer limited to 5 main menu options, I added a 6th of Gallery, a place where photos and videos would be uploaded. Additionally I spent some time adjusting the way the menu was displayed on mobile devices. Originally when the user clicked the 3-horizontal lines menu icon, every single menu and submenu option was displayed at all times, creating a very large overwhelming list of options to choose from. Instead I wanted to collapse the menu so the viewer only saw the main 6 menu options, and then is allowed to click on one to expand and view additionally options. I was able to find and install another plugin

called Responsive Menu which allowed me to do just that. The plugin also allowed the user to change a variety of other aspects, like colors, menu icon, how much screen space the menu used when opened, and the ability to remove the menu that came with WordPress 2014 and replace it with this one.

The final step in creating the app was incorporating the actual text, photos, and videos. Much of the text was copied over from the previous app, however I did make several edits. There were many times I shortened the text for a section to be more appropriate for a mobile device. The longer more extensive text on the former app was conducive to being read on an iPad, but as the new app was also (if not more predominantly) to be viewed on phones, the text needed to be shorter so as not to lose people's attention. As for the photos seen on each page, I had previously gone through all of the photos given to me by Demi Fox from her collection and sorted based on which ones I liked best for which page. As one of the issues with the old app was the videos not working, I needed to come up with a solution to make the videos more stable. I therefore created a YouTube account for the project, uploaded all videos there, and simply added the URL of a video on the app page. WordPress will recognize links from YouTube and automatically incorporate them in a page. I also edited several videos using Final Cut Pro to combine multiple similar segments into one continuous video. A complete flow chart of the layout of the current web-app can be found in Appendix I.

III. Citizen Science

Utilizing the public to help with scientific research is a concept that has been around since the start of the 20th century. The earliest known citizen science project began in 1900 with the Audubon Society Christmas Bird Count (Silvertown, 2009). Citizen science projects in the past have required pen and paper to record observations, which can lead to errors, difficulties in data visualization (ex. describing a particular species), and slow processing of the data (Jambeck & Johnsen, 2015). However, technological advancements have made the data collection process much easier and faster. Several organizations have created apps for citizens to collect data in the field. One example is the Secchi app created by researchers at Plymouth University's Marine Institute. This app

allows people to record and submit secchi disk measurement, which help researchers determine the amount and location of marine phytoplankton.

To take advantage of this available technology, it was decided that a citizen science component would be added to the Nai‘a Guide 2.0. This section will allow citizens to upload photos of spinner dolphins, along with importing their GPS location to geo-locate the photos, to aid in photographic identification efforts as well as capturing the intense tourism pressures. As the technical ability to create this type of interface is beyond my skill level, a company called Gaia Resources based in Australia was contracted to build it. This particular company has worked on other similar marine citizen science efforts, such as the Coastal Walkabout and Dolphin Watch apps. Although this part of the project will extend beyond graduation due to a backlog at Gaia Resources, the interface for Nai‘a Guide 2.0 is expected to be similar to the previously mentioned apps (Appendix II).

The data gathered from this effort could be used in future research, not only for photo ID of the dolphins, but also to aid in enforcement efforts of harassment. As the photos would be tagged with GPS coordinates, this would allow enforcement officers to know where to concentrate their efforts and potentially which companies to monitor more closely. By allowing people to upload photos, it may encourage a community policing system as resources for state or federal enforcement are limited. Of course with this type of citizen science, there is always the risk of untrained citizens getting too close to the dolphins, putting themselves and the dolphins at risk. Therefore it will be necessary to have a page appear prior to being able to upload photos describing proper behaviors in taking photos and interacting with the dolphins.

IV. App Search

a. Background and Methods

Despite the best efforts of the small number of citizen science and marine conservation apps that are currently available, these apps are useless if no one knows about them or can find them. One study revealed that about half of all Apple and Android users will search for apps in their respective stores-iTunes for Apple and Google Play for Android

(Mobile Dev HQ, 2014). This fact highlights the importance of an effective search function so that a user can find exactly what they are looking for. I wanted to determine the effectiveness of the search functions in both app stores, so I performed a key word search in both locations and evaluated the search results for relevance.

In a previous study done by Demi Fox in 2012, the search results of 4 different key words in 8 different categories were evaluated to determine the total number of apps available (Appendix III). At that time there were about half as many apps in both stores as there are today, but the results showed the 4 keywords searches represented a very minimal proportion of the total number of apps (Fox, 2013). However since that time, the desktop iTunes has been updated and the search functions have unfortunately become more simplified. No longer are you able to easily do an advanced search with multiple search components, for example searching for ocean apps within education. You can now only search for ocean apps within all categories. Because of this search engine change, people have published online a link to a power search function within iTunes. However, that requires going online, searching for iTunes power search, clicking the link, and then searching. In addition to this added process most people would not go through, the link will not work on mobile devices, essentially making the power search useless for our study.

As I am attempting to determine what an average person would search for and find, I performed a keyword search in the iTunes App Store on my iPhone (as opposed to the desktop iTunes Store). I did not have access to an Android device, so those searches were done through the online Google Play store. In each location, iTunes and Google Play, I performed a search using the keywords ‘ocean’, ‘conservation’, ‘environment’, and ‘science’ and tallied the results. Since I am unable to search within specific categories, I instead reviewed the top 50 research results for each keyword to determine the relevance of the apps to environmental conservation. Lastly, I wanted to see what people might find when they are trying to find an app like the Nai‘a Guide, but do not have the exact name of the app. Since I know that app is only in the iPad App Store, I only performed this section of the search project on an iPad.

b. Results

I discovered that obtaining a total count of the number of apps available per keyword was not possible for both search locations. Only for the apps in the iTunes store was an individual count taken, as the number of results was displayed in the search box on my phone (Table 1). A total search result count was not possible for Google Play, as only the first 250 search results are displayed for each term.

Keyword	**Number of iTunes Search Results**	**Percentage of Total Apps in iTunes App Store**
Ocean	3,813	0.318%
Conservation	296	0.025%
Environment	1,032	0.086%
Science	5,874	0.490%

Table 1: Raw data of the number of app results for each keyword and the percentage those apps make up in the entire iTunes App Store. February 28, 2015.

The next component of my search was to review the top 50 results for each keyword in each search location to determine the types of apps that were being displayed. As I reviewed the apps, I came up with a list of 15 different categories that all of the top 50 results could fall under (Appendix IV). Several of these results I spilt into environmental based and general, for example 'news/magazine', to better differentiate. However it should be noted that the general apps did often include an environmental segment, it was just not dedicated to the environment. Out of all 15 categories, I focused particularly on the 'citizen science' and 'species education' categories, as they would be most relevant to apps like the Nai'a Guide.

The first keyword evaluated was 'ocean' (Figure 1). For both search locations, approximately 90% of the search results were either games that were not environmentally education (i.e. children's games based in the ocean, but offered no education value) or were some type of sound or visual stimulant (i.e. noise machine with ocean sounds or ocean wallpapers). There were notably a small handful of environmentally educational games. Only one Google Play app was related to 'species education'.

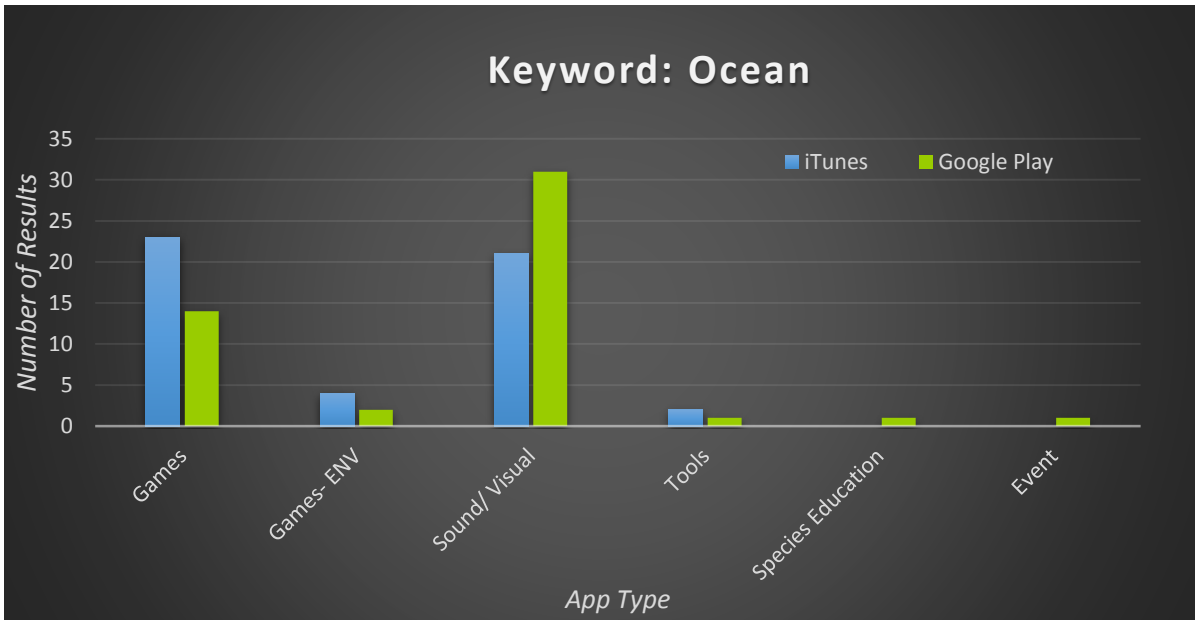

Figure 1: Search results of iTunes and Google Play app stores using the keyword 'ocean'. February 28, 2015.

The second keyword searched was 'conservation' (Figure 2). Unlike the 'ocean' search, this term resulted in a wide range of different categories, encompassing all but one of the 15 categories. The largest number of results fell under 'green living', which mostly included apps on ways to conserve energy or water. However this is somewhat misleading, as the energy conservation apps were each for a specific energy company and most were all the same layout, making each app only applicable to a certain group of people. When 'citizen science' and 'species education' were combined for iTunes and Google Play, these two categories made up 16% and 8% respectively.

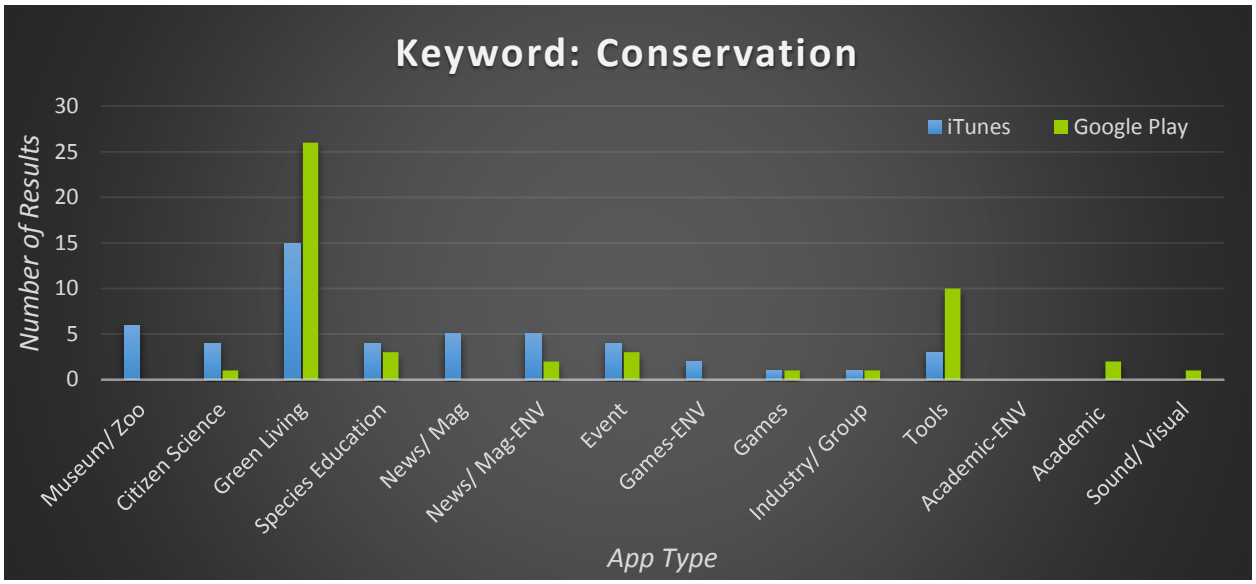

Figure 2: Search results of iTunes and Google Play app stores using the keyword 'conservation'. February 28, 2015.

'Environment' was the third search term, which also resulted in apps ranging across all but one of the categories (Figure 3). However these results were more evenly spread out across the categories. Top results for iTunes included 'news/magazine', 'games', and 'industry/group'. Top results for Google Play included 'industry/group', academic-environment', and 'news/magazine-environment'. So arguably in this case, Google Play did a better job than iTunes of finding relevant apps since more of its top search results were environmentally based. Surprisingly for this keyword, 'citizen science' and 'species education' only comprised 2% of the search results for iTunes and 0% for Google Play.

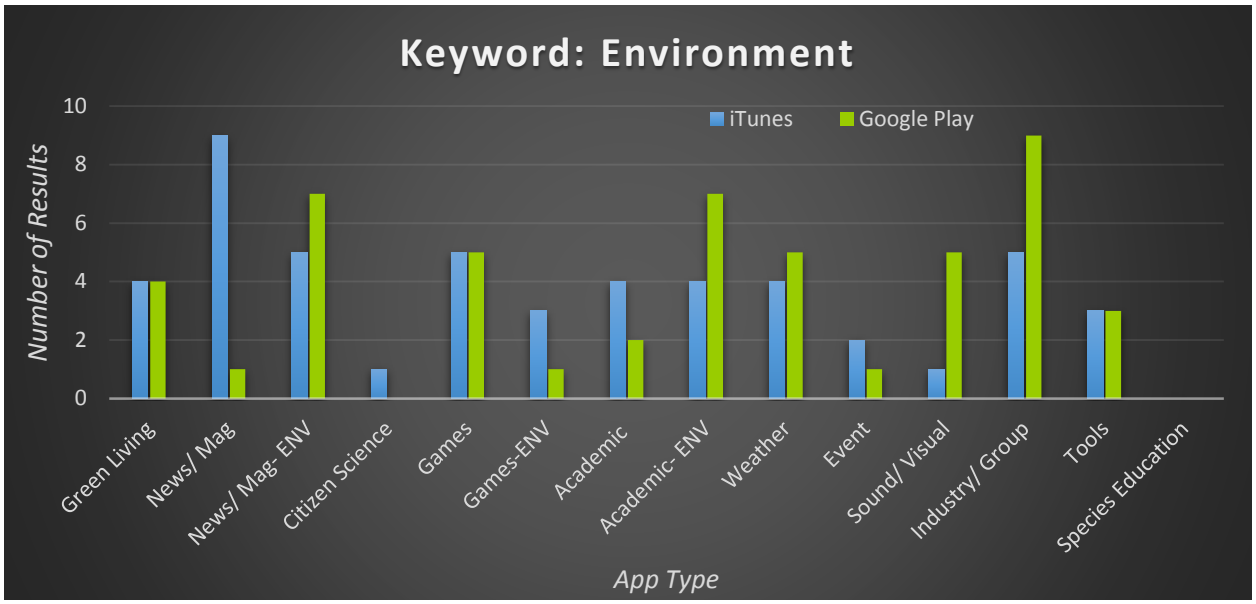

Figure 3: Search results of iTunes and Google Play app stores using the keyword 'environment'. February 28, 2015.

The final keyword searched for this section was 'science' (Figure 4). 'News/magazine' comprised 80% of the search results for iTunes and 'academic' comprised 88% of the search results for Google Play. Less than 10% were specifically environmental related, in this case through educational games. None of the results for either search location were related to 'citizen science' or 'species education'.

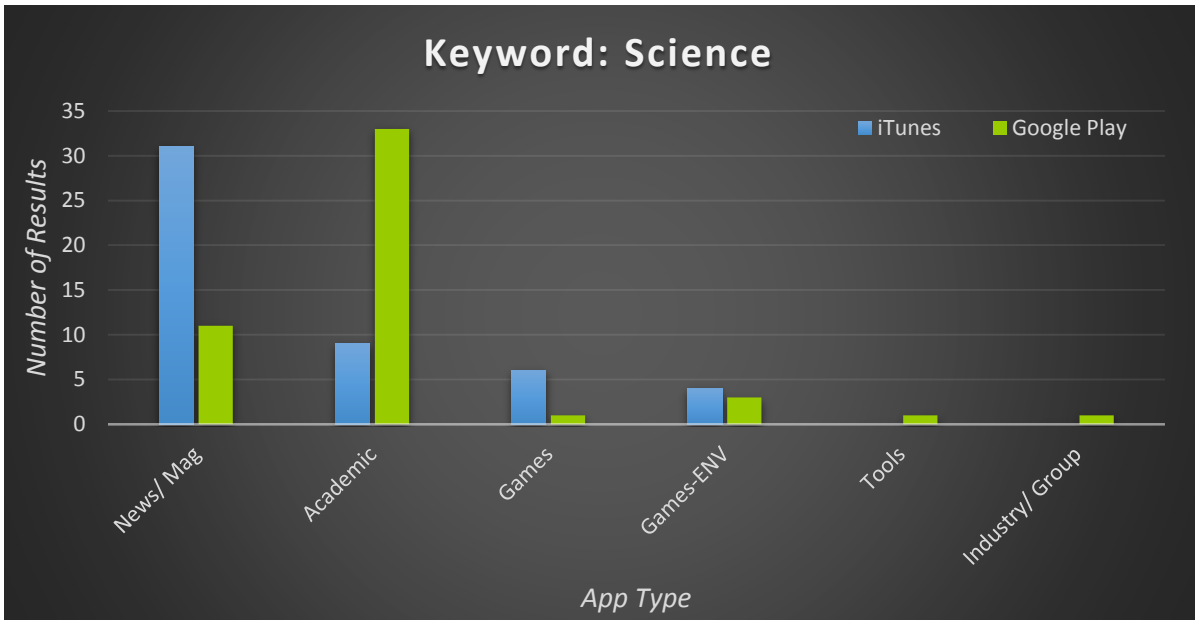

Figure 3: Search results of iTunes and Google Play app stores using the keyword 'science'. February 28, 2015.

The final section of the app search project was to see what certain keywords would allow users to find the Nai‘a Guide. I searched in the iPad App Store using the terms ‘dolphin’, ‘swim with dolphin’, ‘spinner dolphin’, ‘dolphin Hawaii’, and ‘dolphin tour’. Searching the term ‘dolphin’ produced a large number of apps, the majority of which appeared to be children’s games upon initial review. The Nai‘a Guide was number 461 in the search results. The Nai‘a Guide also did not appear in any search results for the term ‘swim with dolphin’, which is unfortunate as that is the primary industry the app was created for. Our app did however appear in the search results for ‘spinner dolphin’ (6 total results), ‘dolphin Hawaii’ (3 total results), and ‘dolphin tour’ (52 total results). We can probably make the assumption though that the average tourist is not going to know these dolphins are spinner dolphins in particular and would be unlikely to search that term. With ‘dolphin tour’, the Nai‘a Guide did not appear until result number 31. Therefore, essentially only one of these 5 search terms, ‘dolphin Hawaii’, provided the best result and the best possible term an average person would search using.

V. Interviews

In order to gain a different perspective on using apps for marine conservation efforts, I decided to conduct a brief interview with several organizations who currently had relevant apps available. My goal in doing so was to create a guide or list of suggestions that other organizations could follow if they were interested in making similar apps. I reached out to individuals within 8 different organizations to inquire about doing an interview. These included, with the app name in parenthesis, Ocean Conservancy (Rippl), Southeast Atlantic Marine Debris Initiative at University of Georgia (Marine Debris Tracker), Oceans Network Canada (Coastbuster), Plymouth University (Secchi), Common Good Productions (Marine Defenders), International Fund for Animal Welfare (Whale Alert), Save the Manatee Club (Manatee Alert), and Stanford University (MPA Guardian). Out of these 8 organizations, 6 responded saying they would be willing to do an interview with me. I submitted my questions to them via email (Appendix V). Of the 6 willing respondents, only 4 returned my questions with answers, despite my follow ups with the two remaining respondents. Regardless of the small sample size, their responses provided valuable insight into the app making process.

The four organizations that completed my interview were International Fund for Animal Welfare (Whale Alert), Save the Manatee Club (Manatee Alert), Southeast Atlantic Marine Debris Initiative at University of Georgia (Marine Debris Tracker), and Oceans Network Canada (Coastbuster). With the exception of the Manatee Alert app, all of the apps were originally initiated by the organization/person I contacted. With Manatee Alert, the app development company Conserve IO actually contacted them to create the app. The International Fund for Animal Welfare (IFAW) specifically stated in their interview that their Whale Alert app was created for a specific problem at that time, which was non-compliant boaters in whale designated speed zones.

Three of the four organizations stated they worked with external partners to help develop the app. IFAW and the Southeast Atlantic Marine Debris Initiative at University of Georgia (UGA) both worked with NOAA. IFAW also worked with the previously mentioned app development company Conserve IO to actually create the app, as did Save the Manatee Club (SMC). Conserve IO not only created the physical app but also maintains it to keep it functional. The Coastbuster app by Oceans Network Canada was developed and maintained entirely in-house. The development of the Marine Debris Tracker app was also in-house, as both the person who initiated the project and the app developer work under the College of Engineering at UGA.

One of the many decisions an organization has to make in creating an app is whether they want to make the app compatible for Apple products, Android products, or both. IFAW and Save the Manatee both created apps only for Apple products. IFAW stated at the time they were developing the first version of Whale Alert, Apple products were more popular, but that an Android app is in the works. Save the Manatee Club stated that if and when funds were available, an Android version would be made. UGA and Oceans Network Canada (ONC) both made Android and Apple versions of their app from the start. Presumably, whether a company can make one platform or both is predominantly dependent on available funds.

In terms of funding, two of the four apps were funded entirely in-house, Whale Alert and Coastbuster. However, IFAW was keen to note the invaluable support of their partners in other aspects of the Whale Alert project. UGA received funding from NOAA for the initial development of Marine Debris Tracker and a small amount for an app upgrade. However, the remaining cost was absorbed by the UGA researchers. Finally the Manatee Alert app was funded entirely by Conserve IO.

After an app has been created, the next challenge is letting the public know it's there. All four organizations stated they used some form of media to announce the app's release, including press releases, announcements in mailings or newsletters, announcements at events or during presentations, social media, or letters sent directly to stakeholders who would use the app. This day in age, with the vast amount of technological resources available, it is much easier to reach a large number of people. However the downside is that all organizations have this advantage at their disposal, which can make the public feel inundated with information. The difficult task for organizations is coming up with a way to make their message or their app stand out.

The final question I asked the organizations in my interview was if they had any recommendations for other organizations looking to create an app. Three of the four all recommended to work with the user groups and stakeholders before and during the app creation to ensure the app fits their needs. Additionally, ONC suggested to think about the marketing strategy during development, such as how to get people to download the app and having people lined up ahead of time to use the app. UGA also had a specific recommendation to use a cross-platform program, such as Titanium Appcelerator, which allows the developer to maintain the Apple and Android versions simultaneously. This eliminates the problem of having to maintain them separately as each platform releases updates.

Discussion and Conclusion

The results from the different components of this study offer a perspective on marine conservation outreach that may not often be considered. My goal for this project was to

ultimately show organizations looking to create an app for marine conservation the various options they can choose and best practices during that process. I also set out to draw attention to the fact that the search functions in the two main app stores, iTunes and Google Play, are not sufficient in their current form to find relevant apps.

By creating a web-based app, I have shown that regular apps are not the only option for organizations looking to create an app. In fact there are a number of reasons web-based apps are more advantageous than normal apps. First, WordPress is designed to be used by people who have no web design background. It is usable to a broader audience and just about anyone in an organization would be able to create it. Unlike regular apps, the organization would not need to pay a developer for a web-based app. Second, because the web-app is nothing more than a website, it will easily conform to whatever type of device and size screen you are using. The creator doesn't have to worry about choosing which platform to create, Apple versus Android or phone versus tablet. As discovered by my trial and error with the different themes for the WordPress site, this conclusion is theme-dependent. On the topic of themes, while there are many paid themes available, there are plenty of acceptable, and in my case better, themes for free, further reducing any cost to an organization. Third, each time the organization wants to update something in the app, they do not have to release an entire new version of the app, unlike with regular apps. They would simply go on the WordPress website and make the changes. Similarly, maintenance of the app is far more simplified as you don't need to keep up with the continuous operating system updates by Apple and Google Play. Many regular apps cannot keep up with those changes rendering them inoperable, but a web-based app is not affected by the updates.

Of course the web-based app is not without disadvantages, the primary one being the limited capacity for adding more technical elements, both due to the limited ability of WordPress and the limited ability of a non-developer using it. WordPress is great for sites with primarily text, photos, videos, and sound clips. However, if you need to add more detail, for example a place for people to upload photos to collect data and import their GPS coordinates as we are doing to the Nai'a Guide, then bringing on a developer to the

project is necessary. Therefore which option you choose, web-based app or regular app, essentially depends on how detailed you need your app to be.

Another downside of web-based apps is the lack of attention publishing the app in an app store would provide. People interested in downloading the app would have to go to a particular website and save the app on their homescreen, rather than being able to search for it in an app store. However, as I have shown with a second component of this project, searching in the app store is not exactly an effective way of finding apps for a particular area.

Given that people rarely go anywhere without their phones, there is a great opportunity for people to directly participate in marine conservation. Smartphones have become highly integrated in our daily lives and can connect people and issues across the planet. Therefore, why not use this to our advantage to further marine conservation efforts? In addition to the data collection helping scientists, there are several reasons why engaging the public in citizen science projects is beneficial. First, as accurately stated by Silvertown, the "best way for the public to understand and appreciate science is to participate in it" (Silvertown, 2009). As these types of projects are all based outdoors, the public is given the opportunity to be immersed in nature (Devictor, Whittaker, & Beltrame, 2010), which is often lacking in today's society.

Second, citizen science projects offer the chance for the barrier that is often perceived between researchers and the public to come down. By having to communicate directly with the public about the project goals, procedures, and outcomes (a skill which many scientists are lacking), researchers "come down from the ivory tower" in the eyes of the public (Devictor et al., 2010). This makes the science more tangible and more applicable in the public's daily lives. One paper makes a terrific point about the incorrect assumption that all science is done by the elite. The authors states that in the past, some of the best scientific discoveries were made by people who participated in science as a hobby, not those in "well-funded laboratories with complex instrumentation" (Lauro et

al., 2014). Such examples cited include Leonardo da Vinci, Gregory Mendel, Michael Faraday, and most notably Charles Darwin.

Finally, citizen science projects can be used in educational settings and incorporated into the school curriculum (Jambeck & Johnsen, 2015). Since the databases containing the imported data are often publically available for some apps, teachers have the opportunity to use that data in the classroom and educate students in a current, hand-on way. Of course like apps in general, using apps for citizen science does have its downsides, namely the need to keep up with the rapidly changing and advancing technology in today's world (Silvertown, 2009).

By searching in the different app stores for apps related to four different keywords, I was able to see both the number and relevance of the search results. The current environmental conservation apps make up an insignificant portion of the total apps available, which could be for one of two reasons. One, there simply are not many apps to begin with or two, the search engines in the app stores are not finding the apps tagged with those keywords. As the second aspect of the app search proved, many of the top search results were not relevant to the actual keyword, making apps difficult to find. Unless the user already knows exactly what app to search for, finding that app may prove difficult. This issue can primarily boil down to the limited search abilities of the search engines in both iTunes and Google Play. More detailed advanced search options should be created in order for the user to better find what they need. As such, organizations cannot rely on the search tool alone for people to find the app. They need alternative ways to get the word out.

In order to learn more about the outreach strategy other organizations used, as well as other app development strategies, I interviewed several organizations that have developed apps. This resulted in several suggestions for future app development. First, utilizing external partners is one step that can be taken to help make an effective app. IFAW noted in their interview that having the variety of partners it did was "key to its [the app's] success and development". Few organizations likely have the expertise to make apps in-

house, which is why companies like Conserve IO have formed to fill that role. Second, I was surprised that not more organizations received grant money for their app development. UGA did receive funds from NOAA and SMC's app was created for free by Conserve IO. However, I expected there to be more private grants applied for or used for this innovative technique. Since funds are almost always limited for non-profits, a web-based app would be a viable option for them.

Third, the outreach strategy for each organization varied, but mostly included some type of press announcement or notification to its members. Finding a way to make your app stand out and reach the intended audience is essential. For example with the Nai'a Guide, we are working with the education department at Dolphin Quest in Hawaii to integrate the app into their education and outreach programs. I have also been communicating with NOAA about incorporating the app into their outreach as part of the Dolphin SMART program. Finally, working with the user groups and stakeholders of the app before and after development is a crucial step that most organizations interviewed recommended doing. This allows for the app to be as useful as possible to the intended audience and for time and resources not to be wasted.

In conclusion, mobile apps, whether web-based or regular, provide a great opportunity for the public to become more involved and educated in marine conservation issues. However they are greatly underutilized and underrepresented in the app stores. Organizations should consider integrating this education tool in their outreach strategies. By taking advantage of today's rapidly advancing technologies, we have the opportunity to reach a wider audience and make a difference in marine conservation issues.

Acknowledgments

I would like to thank my advisor, Dr. Dave Johnston for his support and guidance throughout this project and Demi Fox for providing continuous encouragement. I would also like to thank those organization that took the time to be interviewed, as well as Dolphin Quest and NOAA's Dolphin SMART program for their interest and contribution to the Nai'a Guide.

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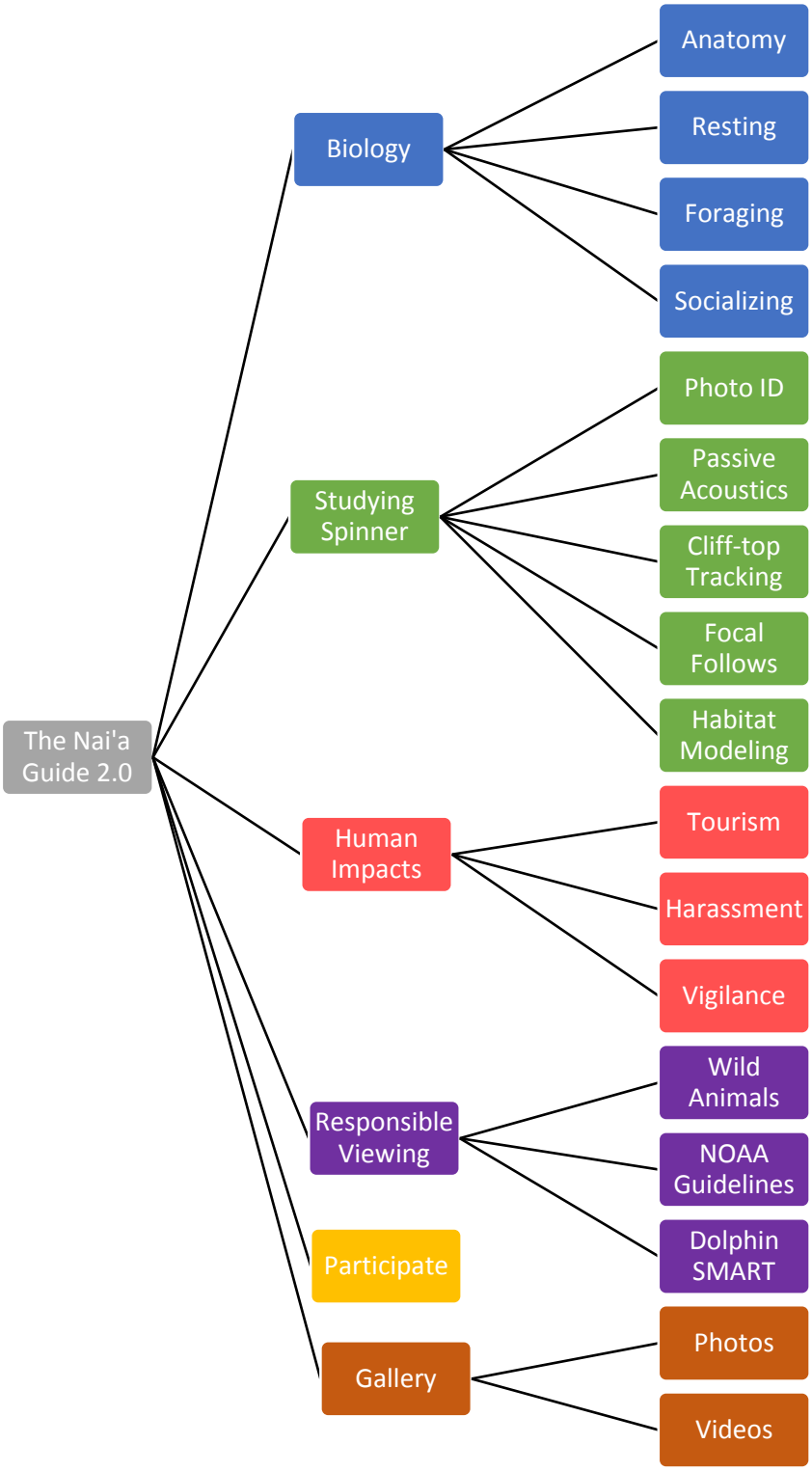
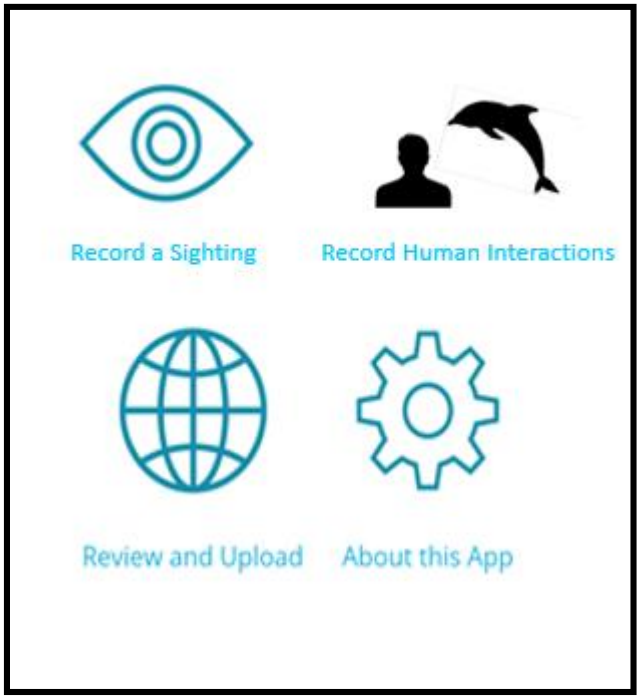
Appendix I- Nai‘a Guide 2.0 Flow Chart



Appendix II- Anticipated design of Participate section in Nai‘a Guide



Appendix III- Exert from Demi Fox's Master Project on her app search

IV: Conservation Apps Study

Methods

I wanted to gain perspective on the number and type of apps that are currently available to download for the purpose of conservation. In October and November 2012, I completed independent research on apps available for Apple and Android devices. I entered four search terms into both the Apple app store (iTunes) and the Android app store (Google Play): conservation, environment, science, and ocean. I counted and recorded the total number of apps returned by each search.

Of the 23 categories of apps available from Apple, I chose eight categories relevant to conservation media to analyze the apps returned from my four searches in the iTunes Store. These categories were: entertainment, news, education, reference, lifestyle, travel, photo and video, and social networking, for both the iPhone and the iPad. I also chose eight of the 26 categories available from Google Play that were most similar to those offered by Apple. These were: entertainment, news and magazines, education, books and reference, lifestyle, travel and local, photography, and social. I counted the number of apps returned by each of my four searches that were listed in these categories and kept a record of all totals.

Results

The two stores returned nearly 11,000 apps. A total of 8,799 apps were returned in the four iTunes searches (Figure 9). When compared to the approximate 550,000 apps supported by Apple, these four search terms returned 1.60% of the total available apps (Apple 2012). The 'conservation' search term returned the fewest number of apps, accounting for only 2.80% of the searches completed here and 0.04% of total apps available on the iTunes Store. Apps returned when 'environment' was searched accounted for 10.60% of the apps searched here and 0.17% of the total apps available. Apps returned when 'ocean' was searched account for 26.56% of the apps searched here and 0.42% of the total apps available. The largest number of apps was returned when

'science' was searched, accounting for 60.04% of the apps searched here and 0.96% of total apps available.

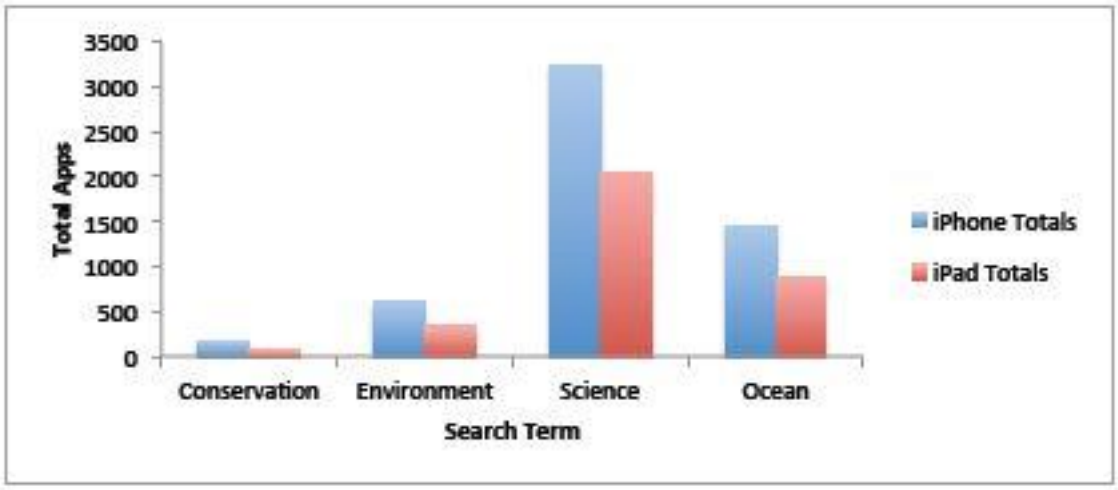


Figure 9: Total number of apps returned in Apple iTunes Store using four search terms: conservation, environment, science, and ocean. October 19, 2012.

Both the iPhone and iPad had similar distributions of categorized apps returned by these four searches (Figures 10 and 11). Within the search terms, social networking apps accounted for the smallest total, comprising 0.34% of the iPhone/iPad apps searched. Apps categorized as education, although often an unfitting title, accounted for 25.63% of the all the apps searched. Next to education, entertainment apps had the greatest total, accounting for 8.58% of the total iPhone/iPad apps searched. Apps categorized as news accounted for only 4.26% of the total iPhone and iPad apps returned by the searches.

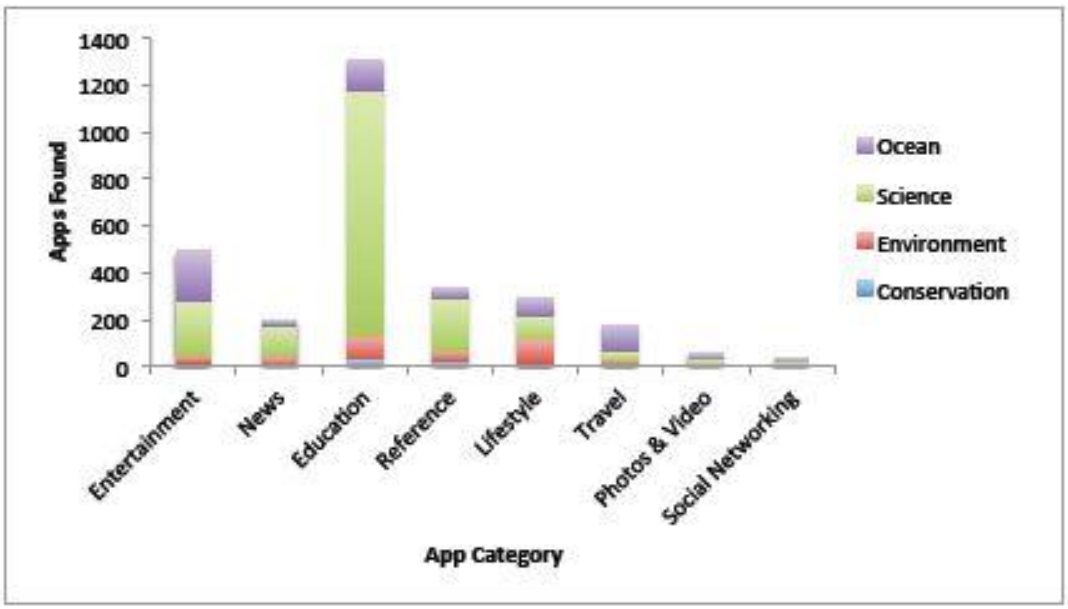


Figure 10: Total number of iPhone apps returned in Apple iTunes Store using four search terms: conservation, environment, science, and ocean. October 19, 2012.

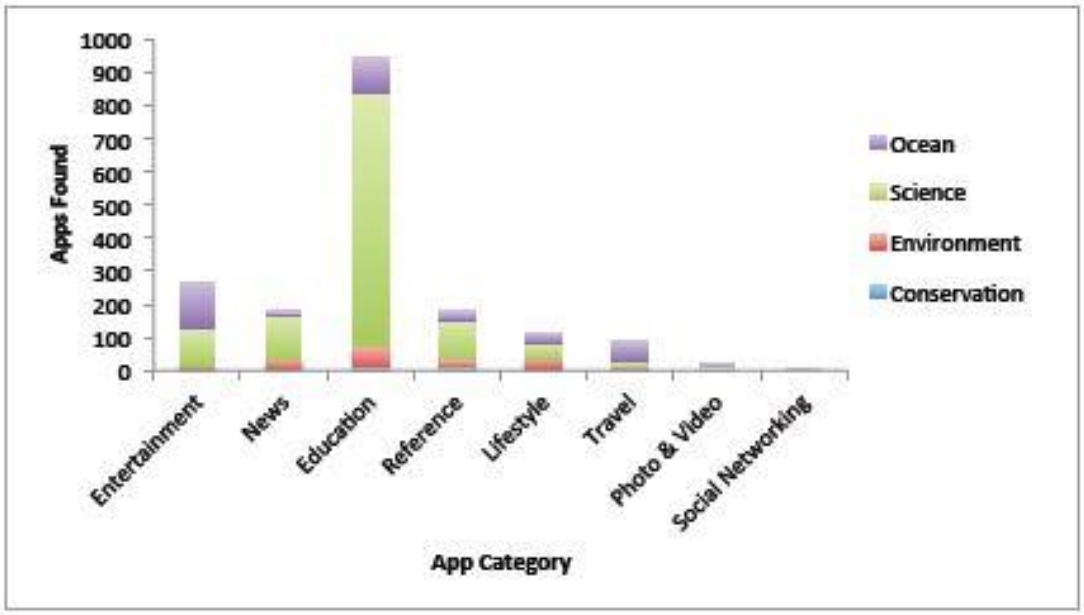


Figure 11: Total number of iPad apps returned in Apple iTunes Store using four search terms: conservation, environment, science, and ocean. October 19, 2012.

Google Play displays only the top 480 apps returned for each search term, 20 pages of 24 apps each. However, for each term used here, a return message revealed that at least 1,000 apps were available. I analyzed the 480 apps that were visible in the four search results (1,920 total Android apps) as those are the apps that would be readily searchable

for smartphone or tablet consumers. Although this standardized the number of apps returned from each search term, categorizing the apps still provides context for the type of Android apps that are searchable for conservation related issues.

After categorizing the apps, education represented the greatest total, 14.48% of the Android apps returned by the four search terms (Figure 12). After education, books and reference apps accounted for largest total, 8.33% of the Android apps searched. Like the Apple searches, social apps had the lowest total, accounting for only 0.94% of the Android apps. Apps categorized as news and magazines accounted for 7.05% of the total.

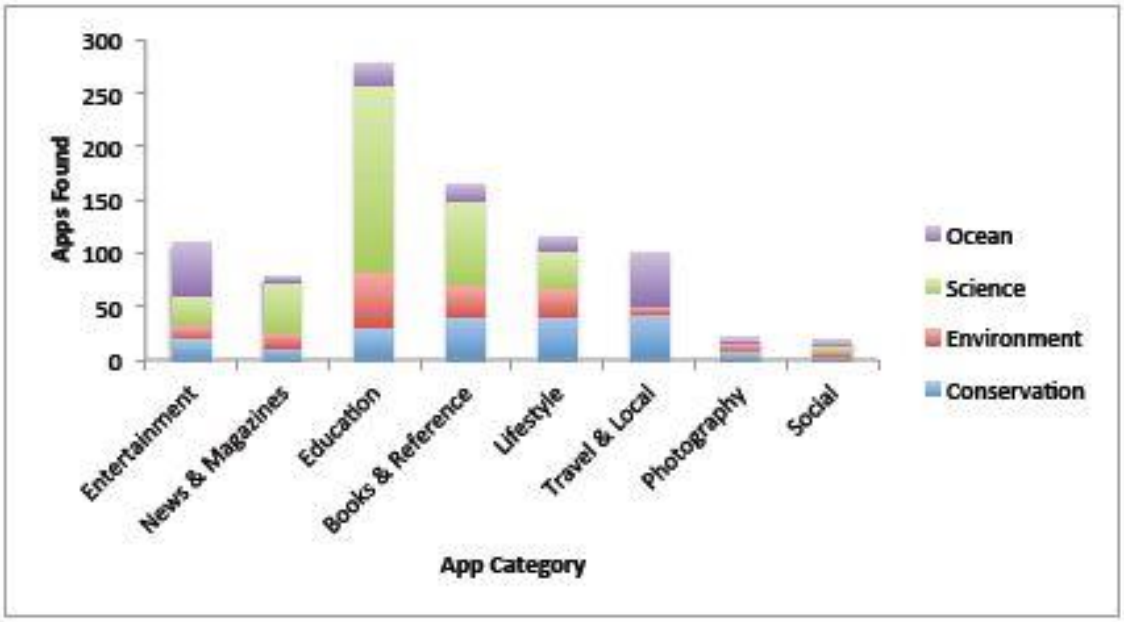


Figure 12: Total number of Android apps returned in the Google Play store using four search terms: conservation, environment, science, and ocean. November 23, 2012.

Appendix IV- App search categories

1. News/Magazine
2. News/Magazine- environmental
3. Game
4. Game- environmental
5. Academic
6. Academic- environmental
7. Industry/Group
8. Sound/Visual
9. Tools
10. Species Education
11. Citizen Science
12. Event
13. Green Living
14. Weather
15. Museum/ Zoo

Appendix V- Questions asked to organizations interviewed

Note: This is the list of questions asked to IFAW on the Whale Alert app. Each interviewee was asked the same set of questions, altered slightly to be appropriate and applicable for each organization.

1. Who (organization) initiated the Whale Alert project?
2. Who did IFAW partner with for the app?
    a. Did you contact them to partner?
    b. If it was possible to make entire app within IFAW, would that be preferable to contracting out?
3. Who monitors the incoming and outgoing data?
    a. What is done with incoming data?
4. Who (organization and person) maintains the app technical functionality (ex. to keep app compatible with new iOS updates)?
    a. Why was it decided to make an Apple version, not Android?
    b. Are there any plans to make an Android version?
5. Why in the new version of the app did you decide to add a citizen science component to the app?
    a. What kind of feedback from the scientific community have you gotten about using an app for citizen science?
6. What part did/does NOAA play in the app? (ex. data collection, advertising, etc.)
7. What outreach has been done to get the word out about the app? Was the outreach done by just IFAW, or did the other partners play a role?
8. How was this app funded?
9. Is there anything you would change in the app creation/ management if you did things over again?
10. Do you have any recommendations for other organizations looking to create similar apps?